POLYFIBROBLAST: A SELF-HEALING AND GALVANIC PROTECTION ADDITIVE

Progress Report #12

Prepared for:

Cody M. Reese
Logistics S&T Thrust Manager
Office of Naval Research
Code 30, Room 1149
875 North Randolph Street
Arlington, VA 22203-1995

Prepared by:

Jason J. Benkoski, Ph.D., Senior Research Scientist
The Johns Hopkins University Applied Physics Laboratory
The Milton S. Eisenhower Research Center
11100 Johns Hopkins Rd, MS 21-N109
Laurel, MD 20723
Tel. (240) 228-5140

Reporting Period: October 25, 2012 through November 26, 2012
Date of Report: November 26, 2012

20121204006

TABLE OF CONTENTS

1 Summary

Jason Benkoski visited PPG's Allison Park Research Center to inspect the microcapsules. Despite the challenges of synthesizing them in larger quantities, the PPG microcapsules looked at least as good as the equivalent APL microcapsules. PPG is now making the 5 gallons of paint for the January field test.

2 Project Goals and Objectives

PPG has brought the microcapsule synthesis to a scale sufficient for producing 5 gallons of paint for the January field test in Camp Lejeune, NC.

3 Key Accomplishments

3.1 Coordinating field test with Andrew Sheetz

Jason Benkoski spoke with Andrew Sheetz from the USMC Corrosion Control Team to discuss logistics for the January field test. The plan remains unchanged. We will choose a week in January that does not fall on a holiday weekend to perform the test. PPG will deliver 5 gallons of self-healing paint to Andrew's team at Camp Lejeune. He will then use a similar procedure to paint one half of the truck bed of an MTVR with self-healing paint, and the other half with zinc-rich primer. Andrew and his team will then perform routine visual inspection of the truck bed periodically as it experiences normal wear and tear. Andrew and Jason will speak again in the first or second week of December to determine a more detailed plan of action.

3.2 Visual Inspection of microcapsules

In last months report, we showed that raising the isocyanate to amine ratio from 1:0.6 to 1:1 appears to accelerate shell-cure to about 4 days. Increasing heat soak temperature and adding an amino-ether catalyst further reduced shell-cure to 2 days. Upon visual inspection, microcapsules made in this fashion look as good as, if not better than, the microcapsules made at APL. Provided that the microcapsules can be filtered, dried, and dispersed into the MIL-P-26915 primer, we would expect good self-healing performance from these microcapsules.

3.3 Filter, dry, and redisperse

An ongoing issue with the microcapsules is the difficulty of taking the aqueous dispersion of microcapsules, purifying them, drying them, and then redispersing them in the MIL-P-26915 primer. Big strides were made last year at APL moving from an expensive freeze-drying process to a simple air-drying process. However, the air-drying process still has reliability issues. Part of the reason that the microcapsules were soaked in water for 14 days was to make the polymer shells thick enough to survive vacuum filtration. Thinner shells deformed under pressure. Once

dried, the deformed microcapsules were difficult to redisperse. The 35% OTS microcapsules tended to filter, dry, and redisperse better than other formulations. The variability in the behavior of the different formulations made it difficult to settle on a single drying protocol for all samples.

PPG is experiencing some of these difficulties. Their strategy so far has been to synthesize excess microcapsules and remove the large aggregates with a sieve. This approach lowers the yield, but with their ability to make 2 kg/hr, they can afford to use this approach until the drying process improves. Based on the relatively low loading of microcapsules, PPG only needs to synthesize a total of 2 kg of microcapsules to make 5 gallons of self-healing primer. After the 5 gallons have been delivered to Andrew Sheetz, PPG will have 3 months to refine the process and improve yields.

4 Next Steps

4.1 Field Test Preparations

Given the urgency of the January field test, PPG will devote most of its resources this month to delivering 5 gallons of self-healing paint.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.
PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
26-11-2012	Performance/Technical Report (Monthly)	10/25/12 - 11/26/12

4. TITLE AND SUBTITLE

Polyfibroblast: A Self-Healing and Galvanic Protection Additive

5a. CONTRACT NUMBER

5b. GRANT NUMBER

N00014-09-1-0383

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Benkoski, Jason J.

5d. PROJECT NUMBER

5e. TASK NUMBER

FGY25

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
The Johns Hopkins University Applied Physics Laboratory
11100 Johns Hopkins Rd
Laurel, MD 20723

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Office of Naval Research
875 North Randolph Street
Arlington, VA 22203-1995

10. SPONSOR/MONITOR'S ACRONYM(S)
ONR

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for Public Release: distribution is Unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The goal of this project is to develop a primer additive that mimics the self-healing ability of skin by forming a polymer scar across scratches. Designed to work with existing military grade primers, Polyfibroblast consists of microscopic, hollow zinc tubes filled with a moisture-cured polyurethane-urea (MCPU). When scratched, the foaming action of a propellant ejects the resin from the broken tubes and completely fills the crack. No catalysts or curing agents are needed since the polymerization is driven by ambient humidity.

15. SUBJECT TERMS
corrosion protection, self-healing, coatings, polymers

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Jason J Benkoski
					19b. TELEPHONE NUMBER *(Include area code)*
U	U	U	UU	4	240-228-5140